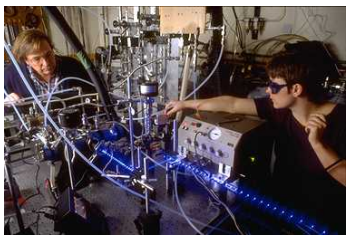
Earth System Research Laboratory
Chemical Sciences Division

Understanding the chemistry of our atmosphere



Chemical Sciences Division scientists conduct laboratory experiments to help improve NOAA's predictions in climate, air quality, and ozone-layer depletion.

The NOAA WP-3D and DC-3 research aircraft and the NOAA R/V *Ronald H. Brown* become "mobile chemical laboratories" to study chemical reactions as part of air quality and climate field studies organized by the Chemical Sciences Division and involving colleagues in other NOAA Research laboratories and other agencies and universities.

Chemical Sciences Division scientists and their colleagues discovered the atmospheric chemical reactions that cause the Antarctic ozone hole. Division scientists continue to study the chemistry and processes associated with the recovery of the stratospheric ozone layer and the interactions between ozone depletion and climate change.

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What does the Earth System Research Laboratory Chemical Sciences Division do for the nation?

The research of the Chemical Sciences Division (CSD) provides a sound scientific basis for decisions and choices made by industry, government, and the public relating to climate change, air quality improvement, and ozone layer protection.

The mission of CSD is:

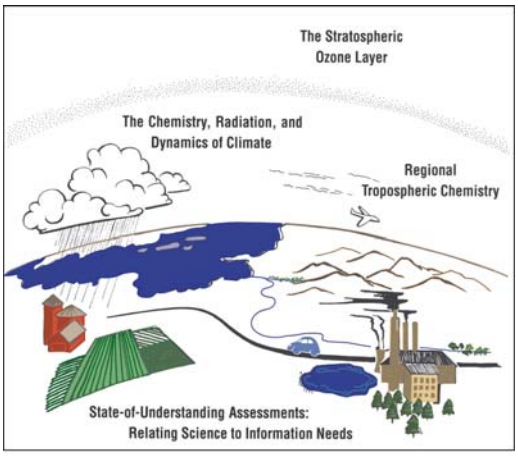
- to conduct scientific research aimed at understanding and quantifying the processes that govern the chemical reactions of Earth's atmosphere;
- to contribute process-level chemical understanding that improves modeling predictions of regional and global phenomena, which lie at the heart of NOAA's mission;
- to communicate scientific information in "user-friendly" terms to NOAA's customers in government, industry, and the public.

Chemical reactions and radiative processes (heating, cooling, and initiation of reactions) drive atmospheric change. Identification and characterization of these processes are needed to build better models of the atmosphere. CSD focuses on understanding the chemical reactions and radiative processes that are important to model predictions of past and future changes in climate, regional air quality, and the stratospheric ozone layer.

In this context of helping to build better predictions, CSD scientists conduct investigations of atmospheric chemistry under controlled conditions in the laboratory, make field measurements in a variety of environments, and carry out diagnostic analyses and interpretations. The Division also assists the scientific community worldwide in providing decision-support information. CSD provides leadership and scientific input to efforts to assess the current state of scientific understanding and interacts with those who use this information. For example, CSD personnel serve as co-chair of the climate-science working group of the Intergovernmental Panel on Climate Change (IPCC) and as co-chair of the international ozone-layer scientific assessment for the U.N. Montreal Protocol.

Recent Accomplishments

- Used a new instrument developed at CSD to obtain the first chemical "fingerprint" of the *individual* aerosol particles that can cause cloud formation. **Payoffs: By identifying the chemical makeup of the ambient particles that are effective ice condensation nuclei, this research improves the capabilities of NOAA's Climate Program to predict cloud formation and its climate and radiative implications.**



- Discovered new factors that cause ozone pollution in the Houston, Texas area, showing that leaks of reactive gases from the petrochemical refineries prevalent in the region were a much larger factor than had been expected. **Payoffs: These research results have altered the policy approach taken by Texas air quality managers, at a savings of 70,000 jobs and $10 billion for the state, and are helping the state to better plan its air quality improvement strategy.**

- Analyzed past observations to show that lower-atmospheric ozone levels in trans-Pacific air reaching the U.S. West Coast from Asia have increased by about 30% during springtime near the surface of the Pacific Ocean over the past two decades, demonstrating that a "natural," unperturbed Pacific no longer exists. **Payoffs: The increase in this greenhouse gas influences the radiative forcing (warming or cooling) of climate and also has implications for regional air quality on the U.S. west coast.**

- Played extensive roles in leading, authoring, reviewing, editing, and/or publishing international scientific state-of-understanding assessments on the climate system, fine-particle pollutants, and the stratospheric ozone layer. **Payoffs: These information products provide key scientific input to pending national and international decisions regarding these three societally relevant topics.**

What's next for the Chemical Sciences Division?

CSD scientists provide Program Management leadership for NOAA's Climate Forcing Program and NOAA's Air Quality Program, and they lead assessment efforts that provide user-friendly information for decision makers in climate and air quality. Over the next five to ten years, scientists at the Division will focus on:

- **Climate**
  - *Climate Change: Chemical Composition, Radiation, and Clouds*
    - understanding the role of aerosol particles and processes in atmospheric heating/cooling, cloud formation and composition, and the alteration of atmospheric chemical composition
    - defining the effect of intercontinental transport and chemical reactions on regional atmospheres and on global climate
    - understanding the radiative effects of water vapor and trace gases in the atmosphere
    - determining the contributions of individual (geographic, sectoral, etc.) emissions to climate forcing and air quality change, and elucidating impacts of climate change on air quality
  - *Stratospheric Ozone Layer Recovery*
    - determining how climate change will affect the ultimate recovery state of the ozone layer and the timing of its recovery, and how changes in the ozone layer affect climate
    - carrying out laboratory chemistry to evaluate the "ozone friendliness" and "climate friendliness" of the series of proposed substitutes for the now-banned ozone-depleting compounds
- **Air Quality**
    - identifying the factors (such as nighttime chemistry and sea-to-land transport) that contribute to ozone pollution in the New England region of the U.S.
    - determining the chemical measurements and diagnostic analyses that are needed as the scientific foundation for the emerging NOAA air quality forecasting service
    - identifying regionally-dependent factors that influence the formation of atmospheric fine particles and their chemical composition across the U.S.

Research Partnerships

Several CSD scientists are affiliated with the Cooperative Institute for Research in Environmental Sciences (University of Colorado) or Cooperative Institute for Research in the Atmosphere (Colorado State University). CSD also has vital research and scientific partnerships with colleagues from other Divisions of the Earth System Research Laboratory (for example, with those building the next generation of air quality forecast models), other NOAA/OAR laboratories, NOAA's National Weather Service and National Environmental Satellite Data and Information Service, NASA, National Science Foundation, Department of Energy, Environmental Protection Agency, private industry, and numerous universities and organizations worldwide.

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